~~Patent Application of Theodore E. Anvick~~

~~for~~

~~Anvick Aperture Device and Method of forming and using same~~

ANVICK APERTURE DEVICE AND METHOD OF FORMING AND USING SAME

~~Cross References to Related Applications~~

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] ~~Not Applicable~~ This application claims priority from U.S. Provisional Application No. 60/420,976, filed on December 19, 2002, the contents of which are expressly incorporated herein in their entirety.

~~Background – Field of Invention~~ BACKGROUND

[0002] 1. Field of Invention

[0003] This invention relates to the design of framework for the reinforcement of structures, including reinforcement for cementations, more particularly, the invention relates to an aperture reinforcement device that girds and cinctures other reinforcement in order to enhance composite and ductile properties of reinforcement arrays.

[0004] ~~Background –~~ 2. Description of Prior Art

[0005] U.S. Pat. No. 6,226,942 to Bonin; Pete J. (May 8, 2001)

[0006] U.S. Pat. No. 6,418,686 to Record, (Jul. 16, 2002)

[0007] U.S. Pat. No. 3,879,908 to Weisman, Victor P. (Apr. 29, 1975)

[0008] U.S. Pat. No. 4,226,067 to Artzer, Richard, F. (Oct. 7, 1980)

[0009] U.S. Pat. No. 4,576,372 to Grutsch; George A. (May 14, 1985)

[0010] U.S. Pat. No. 4,530,191 to Boisbiuche; Arsene G. (Aug. 23, 1985)

[0011] U.S. Pat. No. 4,624,089 to Dunker; Friedrich W. (Nov. 25, 1986)

[0012] U.S. Pat. No. 4,660,341 to Holtz; Neal (Apr. 28, 1987)

[0013] U.S. Pat. No. 4,702,053 to Hibbard; Donald B. (Oct. 27, 1987)

[0014] U.S. Pat. No. 4,715,155 to Holtz; Neal (Dec. 29, 1987)

[0015] U.S. Pat. No. 4,998,393 to Bacna; Juan A. M. (Mar. 12, 1991)

[0016] U.S. Pat. No. 5,058,345 to Martinez; Manuel J. (Oct. 22, 1991)

[0017] U.S. Pat. No. 5,398,470 to Ritter; et al. (Mar. 21, 1995)

[0018] U.S. Pat. No. 5,440,845 to Tadros; et al. (Aug. 15, 1995)

[0019] U.S. Pat. No. 5,487,248 to Artzer; Richard F. (Jan. 30, 1996)

[0020] U.S. Pat. No. 6,088,985 to Clark; Timothy L. (Jul. 18, 2000)

[0021] U.S. Pat. No. 6,237,297 to Paroloy; Richard (May 29, 2001)

[0022] U.S. Pat. No. 6,272,805 to Ritter; et al. (Aug. 14, 2001)

[0023] Until now current and previous truss and panel designs have provided valid construction alternatives to more traditional configurations of building material. However, they have been unfamiliar to and have not been embraced by a construction industry well versed in prevalent wood, concrete masonry and steel building methods. Adoption of more stringent mandatory building code requirements with respect to seismic, wind, and fire resistance and energy conservation has progressed over the years, land and labor costs have risen, and the cost of raw materials has increased. This has

caused the costs of the development of wood, steel frame, masonry block and poured in place concrete structures to rise significantly. Rising maintenance, and energy costs for finished structures have also increased the costs of operation and ownership. The benefits of truss and panel designs address all of these factors, and as a result, their price competitiveness has become apparent, reducing the resistance of the construction and fabrication industries to their use as mass production construction techniques. Both the construction industry and consumers will benefit from the development of faster, stronger, more durable and energy efficient construction techniques and structures employing them.

[0024] Trusses and composite trusses of various kinds have been constructed over the years with a variety of designs, connections, methodology and materials. Some have been designed into space frames as the reinforcement matrix for structural panels with facings of cementatious material. In all such panels, the optimization of structural strength, ductility and consequent composite behavior is clearly desirable. Some have featured a disposition of elements attached so as to form loops or apertures of reinforcement. Such apertures have served to elaborate the embedment of reinforcement in cementations in an attempt to enhance composite action. However, such panels have been deficient in their ductility, that is, the ability to undergo changes of form without breaking or falling apart.

[0025] Building panels of various kinds have been developed over the years incorporating a variety of external facings, reinforcement, and internal insulating materials. Prefabricated panels are factory made and shipped to a site for assembly into interior and exterior walls of a building. Some panels are also made directly at the building site. Such prior panels typically have a framework, commonly of wood or metal studs and or wire, readymade with an insulative core and sometimes incorporating electrical wirings and plumbing. Prefabricated panels have means for attachment to each other along abutting edges and for attachment to roof trusses, rafters, flooring and foundations. Panels have been constructed to withstand the various types of forces that buildings typically undergo such as compression forces from floor loads and roofs. Such

panels have also been designed to provide insulation, weather-tight sealing, and to be connected to adjacent panels, roof systems, and to footers. The panels have typically been connected to roof trusses or rafters using conventional brackets, which are nailed to the wooden rafters or trusses and to wooden headers.

[0026] The brackets are designed to withstand the forces exerted by seismic events and the lifting forces exerted upon roof structures by wind. The structural systems of a building resist such forces well to the degree that they enable the building to behave as a unit under stress rather than failing at points of attachment or across surfaces, weakening the structure and making it susceptible to catastrophic failure. The degree of composite, or unitized, behavior of a structure and of the elements used to build it increases with increased ductility of structural interconnection.

BRIEF SUMMARY OF THE INVENTION

[0027] The present invention is directed towards a means to construct monolithic composite insulated structures from elements that can comprise a panel system and that address composite behavior and ductility of structures. Said structure not only provides superior strength against compression and tension forces longitudinally, and laterally, and transversely but also anchors, braces, positions and strengthens structural trusses in a truss system. Walls, roofs, floors, and foundations are tied together in such a manner as to provide a greatly increased tension and compression and shear strength and resistance to lifting and shaking forces.

[0028] Embodiments of the invention can include a static structural reinforcement connecting element comprised of an aperture created by a predetermined disposition of reinforcing members. An aperture according to the invention can be formed by any arrangement of elements of a truss, including an aperture formed when a cord element or continuous web element is bent, folded, tied, woven, or formed to a curvilinear waveform, aperture, or loop to provide means for containment or girding of reinforcement within the area bounded by one or more truss elements. The aperture device provides means for ductile connection of reinforcement, and an aperture created

by the inventions method of arrangement of one or more reinforcement elements girds and interconnects reinforcement in a framework providing means for a composite and ductile erection. The assembly and method of the invention provide means to attain higher ductility and composite action in structures. Embodiments of the invention can have various specification, which can be tailored as to longitudinal truss elements, lateral cross elements, freely locatable reinforcement apertures, insulation cores, transverse spanning reinforcements, and cementation components as to design, size, spacing, materials, methodology, and manufacture as required by any particular engineered demands to provide means for strength and versatility use.

[0029] Elements of the invention can be formed of cut, bent, woven, shaped, folded, looped, formed, twisted, tied, straight or curvilinear reinforcement elements, and elements can be attached to each other by being bent, folded, tied, woven, or formed to each other. Elements of the invention can include materials selected from the group consisting of mineral, metal, fiber, or chemical. For example, structural elements from the family of wood, steel or other materials commonly used in structures can be fitted to act as cord elements or other reinforcement elements, with such elements becoming incorporated into the final composite structure and providing a means to develop a stronger bond and shear transfer within the hybrid assemblage of structural elements.

[0030] Trusses according to the invention can be fabricated with a multiplicity of apertures along the horizontal length. Alternating side to side thus providng means for the allowance, communication, and flow through of said apertures by cross member reinforcement. The aperture device may be disposed in a plurality along transverse faces of a truss providing a means where the reinforcement transfers forces through the reinforcement matrix in both tension and compression. The aperture may be formed by the innermost cross-sectional face of a web vertex and the outermost cross-sectional face of an inwardly mounted cord element, leaving sufficient space for insertion of substantially perpendicular reinforcement, providng means for unification of a predetermined plurality of trusses, and reinforcement elements in longitudinal, lateral, and transverse axis.

[0031] In an embodiment of the invention, a truss system comprises a plurality of trusses arranged in spaced apart, generally side-by-side relation embedded within a plurality of elongate insulation core braces, each individual core brace extending between and engaging adjacent trusses thus maintaining a desired spacing there-between, the braces being arranged in a row extending generally orthogonally to the sides of the trusses such that the longitudinal axes of the braces and the trusses are generally coincident, said plurality of trusses compressively positioned by and between said insulation core modules, and interleaved between adjacent individual insulation panels at a predetermined spatial arrangement and relationship and extending the predetermined span of said cementation in such a manner that said cores are centered transversely in the truss webbing between said appositional chord elements providing means for correct reinforcement embedment within the appositional cementation layers, and providing a vapor barrier, a means of insulation, and spatial alignment of said trusses.

[0032] The connecting aperture device and method of the invention includes an aperture comprised of the predetermined disposition of web vertex, and cord elements of a truss or lattice structure are formed or bent at angles to the web so that they lie flush to one another to provide a means of rigidly affixing them together side by side, and align to one another contiguously to provide means for the free passage through and containment within said aperture device of crossing substantially perpendicular reinforcement elements. Each truss in a given plurality may be rotated in an opposite direction from adjacent trusses such that each truss affixed to each adjacent truss's appositional and adjacent mating aperture provides means to form a three dimensional panel, and folded plate structure. A truss structure may be elaborated by assembling said trusses edge to edge in planes which intersect at aligned parallel longitudinal lines of vertices which alternate transversely from side to side of the resulting three dimensional space frame, said aligned vertices consequently also forming lateral parallel lines of the resulting system in a predetermined disposition such that they provide means to form said device. The curvilinear and/or waveform webbing provides means for a three dimensional structural action once lateral or cross reinforcement and facings of cementations are installed. Lateral and transverse axes in cross section consequently resemble the

longitudinal cross section, consisting of alternating triangular forms, neighboring triangles inverted, between parallel lines, the bases of said triangular cross section composed of either truss cords or lateral reinforcement passed through the cincturing vertices along the intersecting planes of the longitudinal trusses. The cords and lateral reinforcement may form alternating lines transversely from side to side of the space frame along its longitudinal and lateral axes at the alternating vertices of the continuous web elements initially described. The alternating intersecting planes of trusses across all three axes of the consequent space frame form substantially square based pyramidal structures affording a three dimensional structural matrix. Each cinctured vertex of the frame can be one corner of the square base of one or more said structures, depending upon its location at an edge, corner, or in the field of a panel of this configuration of space frame, as well as the summit vertex of an inverted neighboring one, the alternate square bases forming the substantially planar opposite surface lattices of the space frame.

[0033] Truss elements comprising one cord and one web may be formed or bent of said web elements so that apertures are created at the web vertices without an affixed cord in simple, and/or compound angles to said lattice in a manner to allow the insertion, and passage through, and cincture of longitudinal reinforcement or lateral field cords to any other cord or reinforcing element for use as a cord in apposition, which provides means to utilize said lattice for adding shear at panel ends, and around openings in panels, and at intersections of structures, and for construction of box beams, and three dimensional panel systems, and to allow diverse structures to be placed together and rigidly affixed to one another juxtaposed so that there is a sharing of cords in apposition providing a means for design flexibility.

[0034] An aperture equipped truss may be used as a spacer and support device for installation girding the cords of adjacent trusses providing means for alignment and bracing of components during construction and after completion of construction. Lateral cross member reinforcement may be installed after welded wire mesh or materials from the group consisting of fibrous, or sinuous materials, or other sheeting goods have been positioned so that said apertures protrude through said mesh or sheeting and provide a

cincturing or girding and combining, providing means for increased ductility and composite action. Lattice elements containing pre-spaced cinctures can be laid flat, web face towards the ends of the plurality of elongated lattice elements and provide a cinctured spatial alignment device that will add rigidity to the framework prior to the cementation and provide additional reinforcement and composite action, and ductile properties to the structural cementation.

[0035] A cincturing aperture can be provided by rigidly affixing a web element to at least two cords by sandwiching, and or by weaving, and or folding, and/or bending, and said web element may be rigidly affixed to one or more cord ~~chord~~ elements in opposition forming one or more apertures in parallel or tangential or angular opposition for insertion of reinforcement elements of an elongated and sinuous nature to span between said apertures interconnecting, and girding, and cincturing said spanning reinforcement to said elongated lattice framework containing a plurality of said cincturing apertures along its span.

[0036] In a further embodiment of the invention, a freely locatable aperture cincture element comprised of bent, woven, or folded continuous loop reinforcement provides a means for attachment of structural elements into a composite network of reinforcement or to adjacent structural elements of an assembled framework and for connectivity to prior art components preventing relative movement of said attached elements to achieve higher ductility and transverse composite unification in tension as well as compression.

[0037] A modular component composite panel system assembled according to the invention may comprise a plurality of longitudinally extending spaced web trusses containing apertures and is secured to appositional cementations, and other structures sandwiching a insulation core.

~~Brief Description of the Drawings~~ BRIEF DESCRIPTION OF THE DRAWINGS

[0038] FIG. 1A is a perspective view of a curvilinear ~~Curvilinear~~ web element.

[0039] FIG. 1B shows perspective view of a truss formed from web elements such as that of FIG. 1A and cord elements, the truss having ~~with~~ apertures formed between web vertices and dual attached cords.

[0040] FIG. 1C shows a perspective view of a truss with apertures formed between angled vertices and attached cords.

[0041] FIG. 1D1 shows, in perspective view, one pair of parallel trusses 12a such as that depicted in FIG. 1B assembled in an array to form a panel assemblage.

[0042] FIG. 1D2 shows, in perspective view, one pair of intersecting trusses 12b such as that depicted in FIG. 1C assembled in an array to form a panel assemblage.

[0043] FIG. 1E shows a longitudinal cross section of a plurality of trusses 12b such as that depicted in FIG. 1C assembled into ~~in~~ an array to form a panel assemblage such as that depicted in FIG. 1D2 ~~FIG. 1D~~.

[0044] FIGS. 1F (side view) and 1G (perspective view) show ductile right angle truss aperture interconnections (e.g. wall and floor).

[0045] FIG. 2A shows, in perspective view, a truss aperture formation created by weaving of the web element over the cord.

[0046] FIG. 2B shows, in perspective view, lateral reinforcement cinctured by apertures formed by alternating web vertices.

[0047] FIG. 2C is a side view of a lateral cross section of a wrapped web cincturing both cord and lateral reinforcement.

[0048] FIG. 2D is a side view of a longitudinal cross section of a woven web aperture cincturing cords and a lateral.

[0049] FIG. 3A is a top view of an independent locatable cincturing device.

[0050] FIG. 3B is a perspective view [[s]] of the [[~~an~~]] independently locatable cincturing aperture device of FIG. 3A.

[0051] FIG. 3C shows a perspective view of reinforcement cinctured at a right angle by the aperture shown in FIGS. 3A and 3B.

[0052] FIG. 3D shows a perspective view of cincturing of a point loaded dual web 7a, 7b, lateral reinforcements, a cincture-tightening bar and a longitudinal cord 8e.

[0053] FIGS. 3E, 3F show side and perspective views, respectively, ~~differing views~~ of an alternate independent aperture device.

[0054] FIGS. 3G, 3H show perspective views of crossing and lapping cinctured by an independent aperture device, with FIG. 3G depicting crossing and lapping cinctured, and FIG. 3H showing a ductile lap connection.

[0055] FIG. 3I shows a front perspective view of another independently locatable aperture.

[0056] FIGS. 3J (front perspective view), 3K (side view) show the use of the aperture drawn in 3I.

[0057] FIG. 3L shows a front perspective view of a locatable aperture 13f restraining reinforcement at a cord 8a, 8b and vertex 6 cincture.

[0058] FIG. 3M shows a perspective view of a mesh ~~Mesh~~ reinforcement cinctured between cords and lateral via truss aperture, the mesh in turn serving as a locatable cincturing device.

[0059] FIG. 4A shows a perspective view of an insulative panel core element grooved to position and dispose truss webs.

[0060] FIG. 4B shows a side view, in partial cross section, of a truss with curvilinear web integrated into grooves of an insulative core element and sheeting elements cinctured between the perpendicular cords.

[0061] FIG. 5A shows a side view, in partial cross section, of a foundation ~~conection~~ connection, truss, core, and cementation design alternative.

[0062] FIGS. 5B, 5C show side views, in partial cross section, of composite formats with alternative aperture and positioning devices.

Reference Numerals

[0063] 6, 6a-j Web vertices, vertices of independently locatable elements

[0064] 7, 7a,b Web

[0065] 8 Reinforcement element

[0066] ~~8,~~ 8a,b Cord of truss or longitudinal reinforcement element.

[0067] 8c,d Lateral or cross reinforcement element

[0068] 8e,f Cord of truss or longitudinal reinforcement element passing outside of the web or element vertices

[0069] 11 Aperture

[0070] 11a, b Positionable truss aperture for ductile inter-truss connections

[0071] 12a, b, c Truss

[0072] 13a-j Independently locatable cincturing aperture devices

[0073] 13a Locatable CU clip element

[0074] 13b Locatable CU clip element

[0075] 13c Locatable W clip element

[0076] 13d, e Alternate cincture apertures

[0077] 13f ~~Cinctured sheeting element~~ Alternate locatable cincturing aperture

[0078] 13g Cinctured/cincturing lattice or welded wire fabric

[0079] 13h, i, j Alternate locatable apertures

[0080] 14 Positioning Groove

[0081] 15 Insulative core element

[0082] 16 Core longitudinal by transverse face

[0083] 17 Cinctured sheeting element

[0084] 18 Aperture footing reinforcement members

[0085] 19 Aperture truss footing reinforcement and longitudinal member spacing element

[0086] 20 Cementations

[0087] 21a,b Core restraining element

[0088] 22 Panel assembly

~~Preferred Embodiment – Description~~

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0089] A preferred embodiment of a frame forming the aperture 11 of the present invention is comprised of a continuous reinforcement element or web 7 shown in (FIG. 1A) bent to a curvilinear waveform forming vertices 6. A ~~and comprising a web 7 of a~~ truss 12a (FIG. 1B) is formed by affixing one or more cords ~~chords~~ 8a, 8b to said web 7 at a predetermined location such that each vertex 6 extends beyond the attachment location of cords 8a, 8b forming an aperture 11 of predetermined size. An array of reinforcement comprised of a plurality of trusses 12a (FIG. 1B) are integrated into a space frame shown in FIG. 1D1 ~~(FIG. 1D1)~~ of predetermined length, width, and thickness by the insertion and attachment of lateral reinforcement 8c,d of predetermined size through aligned apertures 11 of spaced trusses 12a.

[0090] Truss 12a may be disposed in spatial relationships with its neighbor by elements of an insulative core shown in FIG. 4A ~~(FIG. 4A)~~, whose grooved transverse faces 16 fit the central web area of trusses 12a. Space frame (FIG. 1D1) is built up from interspersed trusses 12a and insulative core elements 15. The predetermined dimensions of core elements 15 dispose and establish truss 12a spacing, and truss 12a in turn positions core elements 15 in relation to space frame (FIG. 1D1) reinforcement attachments to allow required embedment in the event cementations (such as the cementations 20 in FIG. 5A) are applied.

[0091] In another preferred embodiment, aperture 11 (FIG. 1C) is formed in truss 12b by attachment of cords 8a,b to web 7. Cords 8a,b are distinguished by being located on laterally opposite sides of web ~~Web~~ 7 without regard to their transverse relative position. Vertices 6a of web 7 (FIG. 1C) are bent at equal but opposite angles on transversely opposite sides of web 7 (FIG. 1C). A space frame (FIG. 1D2) comprises a plurality of trusses 12b with each truss 12b rotated 180 degrees from its neighbors around a

transverse axis. Then each truss 12b in a given plurality is spaced, positioned and rotated equally and in opposite directions from its neighbors around a longitudinal axis so that the angled vertices 6a (FIG. 1D2 ~~1D~~) of neighboring trusses 12b lie flush with each other, sandwiched between two cords 8a or 8b. Paired apertures 11 (FIG. 1D2 ~~1D~~) are then integrated laterally by the insertion of lateral reinforcement 8c,d through and attachment to aligned apertures 11 formed by ~~comprised of~~ the bounding vertices 6a and cords 8a,b of the space frame array (FIG. 1D2 ~~1D~~).

[0092] Space frame (FIG. 1D2) is shown in longitudinal cross section in FIG. 1E ~~(FIG. 1E)~~ presenting a folded plate truss structure comprised of lateral reinforcement cords 8c,d interconnecting and cinctured by apertures 11 formed by vertices 6a and longitudinal truss cords 8a,b. Truss web elements 7 serve in longitudinal, lateral, and transverse truss structures intersecting, in space frame (FIG. 1D2), to form substantially quadrilateral-based pyramidal structures. Each pair of vertices 6a and cincturing apertures 11 form the apex, or summit vertex, of a pyramidal structure and also one corner of the square base of a neighboring inverted pyramidal form. The intersecting folded plate truss structures of the space frame (FIG. 1D2) and (FIG. 1E) thus provide three dimensional structural action. In this preferred embodiment, appropriately shaped and grooved core elements similar to that depicted in FIG. 4A ~~(FIG. 4A)~~ may also be used to dispose, position, and assemble space frames (FIG. 1D2) from trusses 12b and lateral reinforcement 8c, 8d, thereby forming modular panelized insulative core and reinforcement components for embedment in cementations.

[0093] In another embodiment perpendicular ductile truss aperture connections 11a, b in which apertures 11 (FIGS. 1F and 1G ~~and 1H~~) are formed ~~arenformed~~ by two connected web elements of two trusses and are overlapped in the area of truss ~~inter~~interconnection such that lateral reinforcement 8c, 8d passes through apertures of both trusses at interconnection points 11a and 11b. Truss cords 8e, 8f are affixed at the outer points of the vertices 6a, 6b of web elements 7a, 7b.

[0094] FIG. 2A depicts a further embodiment of the invention, where apertures 11 ~~Apertures 11 (FIG. 2A)~~ are formed by the weaving and attachment of web 7b, 7a

elements around dual cords 8b, 8a to form vertices 6b, 6c each of which wraps one cord 8a, 8b to form a cincturing vertex 11.

[0095] FIG. 2B depicts a further embodiment of the invention, where a truss ~~A truss 12 (FIG. 2B)~~ is configured with vertices 6d, 6e alternating from side to side of a single cord 8a forming cincturing apertures 11 girding lateral reinforcement 8c [[~~, d~~]] .

[0096] FIGS. 2C and 2D depict further embodiments of the invention, wherein apertures ~~Apertures~~ 11 are formed ~~(FIGS. 2C and 2D)~~ by the bending, weaving, sewing, or tying of web 7 into a loop. As depicted in FIG. 2C, a ~~A~~ lateral cross section view of an aperture 11 thus formed ~~(FIG. 2C)~~ shows lateral cross reinforcement element 8c and longitudinal cord 8a girdled and cinctured by web 7. Three vertices 6h, i, j and three apertures 11 are formed.

[0097] A longitudinal cross section view is shown in FIG. 2D ~~(FIG. 2D)~~ of two truss cords 8a, 8b and perpendicular lateral reinforcement 8c, d girdled and cinctured by aperture 11 formed by continuous web 7 on a similar principle of bending, weaving, sewing, or tying.

[0098] Apertures 11 according to the invention can also be ~~are~~ formed by independently locatable cincturing aperture reinforcement elements 13 of predetermined dimensions. Examples of such locatable cincture are depicted in FIGS. 3A through 3M. ~~(FIGS. 3A and 3B)~~. The locatable cinctures may be formed by bending, weaving, or folding a continuous loop of reinforcement material into a desired shape, such as the shapes depicted in FIGS. 3A through 3L. Locatable cinctures according to the invention provide a means for attachment of structural elements into a composite network of reinforcement or to adjacent structural elements of an assembled framework. The locatable cinctures can be used connect components of the current invention as well as prior art components, with the resulting connection preventing relative movement of attached elements to achieve higher ductility and transverse composite unification, in tension as well as compression.

[0099] FIGS. 3A and 3B depict top and perspective views, respectively, of a locatable cincture 13a according to an embodiment of the invention. The particular locatable cincture 13a depicted is a continuous loop forming opposing vertices 6g, 6h and an aperture 11. In FIG. 3C, ~~(FIG. 3C)~~ an application of the locatable cincture 13a cincturing two reinforcement elements appears. Cincture 13a saddles one reinforcement element 8, and a second reinforcement element 8 is then communicated through the girding apertures formed between the saddled reinforcement 8 and the vertices 6g or 6h of cincture 13a left unoccupied by the saddling procedure.

[00100] An application of locatable cincture 13b to web 7, cord 8e, and lateral reinforcement 8c [[~~, d, 8e~~]] appears in FIG. 3D ~~(FIG. 3D)~~.

[00101] Views of a further embodiment of locatable cincture 13c, which can be applicable as described above with respect to ~~for~~ cincture 13b by saddling and insertion of reinforcement, appear in FIGS. 3E (side view) and 3F (perspective view) ~~(FIG. 3E and 3F)~~.

[00102] A further embodiment of a cincture 13d that can be ~~Cincture 13d~~ used for both crossing and lapping reinforcement is depicted in FIG. 3G (crossing reinforcement) and FIG. 3H (lapping reinforcement) ~~appear in (FIGS. 3G and 3H)~~. The cincture 13d is depicted as forming generally the shape of a "figure 8", with two apertures 11 formed in each loop of the "figure 8." The uppermost of the reinforcement elements 8 passes through both apertures 11 of the "figure 8" of cincture 13d, and additional reinforcement elements pass through "sub"-apertures created between the uppermost reinforcement element and the cincture 13d.

[00103] FIGS. 3I through 3M ~~(FIGS. 3I through 3M)~~ show the form and application of locatable cincturing devices according to further embodiments of the invention. FIG. 3I depicts an independently locatable aperture 13e that can be used with reinforcements. FIGS. 3J and 3K depict the aperture 13e from FIG. 3I used with cords 8a, 8b and lateral reinforcement 8c. FIG. 3L shows a further embodiment of a locatable aperture 13f restraining reinforcement 8c at a cord 8a, 8b and vertex 6 cincture.

[00104] FIG. 3M shows mesh reinforcement 13g cinctured between cords 8a, 8b and lateral 8c via web element 7, with the completed assembly forming truss aperture 11. The mesh reinforcement 13g also serves as a locatable cincturing device.

~~Preferred Embodiment - Operation~~

[00105] The manner of using the aperture device 11 is adaptable to structural requirements of any given form or disposition. Panels can be fabricated and erected as framework reinforcement at site as follows:

[00106] In a preferred embodiment ~~an element of said core 15, panels~~ core panel elements 15 such as that depicted in FIG. 4A are placed on a horizontal surface with an edge 16 facing upward which has been grooved with grooves 14 configured to fit and position a truss 12. In this example, two opposite edges 16 of the core panel 15 element ~~are grooved~~ have grooves 14. An adhesive is applied to said edge 16 and an element of an Anvick aperture (11) composite truss 12a-c configuration is fitted within the preformed grooves 14 which accept half of the girth of the webbing element 7 and position said element with respect to said core panel 15. A corresponding grooved core panel 15 element is fitted on top of the first element and completes the embedment of the first truss 12 configuration. The positioning is such that there is sufficient clearance between the core panel element 15 and reinforcement elements 8a,b,c,d for required embedment in cementations 20 depicted in FIG. 5A. This process is repeated, the core panel elements 15 aligned flush with each other and positioning the truss 12 array, until the desired panel width is assembled. Once said adhesive has set, the resulting panel assembly 22 (depicted in FIG. 4B) can be set in place on an arrangement of reinforcement 18 protruding in a predetermined spatial relation from a previously formed foundation structure in which the lower portion of 18 is embedded, as depicted in FIG. 5A. Independently locatable aperture cincturing devices 13a-j attach the foundation reinforcement 18 to either the lateral 8c,d or longitudinal 8a,b reinforcement elements when the aperture-connecting ~~aperture connecting~~ lateral reinforcements 8c,d are inserted through the apertures 11. Welded wire fabric 13g, or sheeting elements [[~~13f,~~]] 17 can be installed, if called for, prior to the addition of said lateral reinforcement 8c,d, which then

serves to cincture 13g, said fabric, when installed over it. System components alternatively may be fabricated off site.

[00107] The manner of using aperture 11 in another preferred embodiment requires each truss 12b in a given plurality to be spaced, aligned, and then rotated in an opposite direction from adjacent trusses 12b so that they intersect at their corresponding apertures 11. Said apertures 11 of said adjacent trusses 12b are bent at an angle to the web 7 so that they lie flush with one another. Cords 8a and 8b of said trusses 12 sandwich the attached, paired, flush positioned vertices 6a forming paired apertures 11. Reinforcement 8c,d is then inserted and communicated through and girded within said apertures 11 to complete an embodiment's basic array. The resulting array is a folded plate structure with multidirectional truss behavior. Said curvilinear and or wave form webbing 7 provides for a real three dimensional structural action once connecting reinforcement 8,c,d, foundation ~~foudation~~ connections 18, and cementations 20 are installed.

[00108] In this preferred embodiment a truss 12b structure is elaborated by assembling said trusses 12b edge to edge in planes which intersect at longitudinal lines of vertices 6a. Said parallel longitudinal intersections linked by cords 8a,b alternate transversely from side to side of the resulting three dimensional space frame disposed across the lateral axis of the space frame array.

[00109] Aligned sequences of paired cincturing vertices 6a are linked when lateral reinforcement 8c,d are passed through vertices 6a. The linked vertices now also lie along the intersection at reinforcement ~~reinforcement~~ 8c,d of planes formed by the curvilinear web elements 7 of trusses 12b which intersect at parallel lateral lines of aligned vertices. Said parallel lateral intersections alternate transversely from side to side of the three dimensional space frame disposed along the longitudinal axis of the space frame array. Longitudinal and lateral cross sections of the space frame consequently resemble each other, the two sets of intersecting planes presenting triangular cross sectional forms of a folded plate truss structure in both directions. The two sets of intersecting planes, each crossing the lateral axis, formed by trusses 12b, and their web and lateral reinforcement elements along both longitudinal and lateral axes of a consequent space frame intersect to

form substantially square based pyramidal structures. Each cinctured vertex 6a of a frame is one corner of the square base of one or more said structures, depending upon location at an edge, corner, or in the field of a panel of this configuration of space frame, as well as summit vertex 6a of an inverted neighboring one, the alternate square bases forming the substantially planar transversely opposite surface lattices of the space frame. Consequently the transverse as well as the longitudinal and lateral cross sections presents similar triangular forms of a folded plate structure and the space frame array of the embodiment affords true three-dimensional truss operation.

Other Embodiments

Independent Aperture--Description

[00110] A continuous loop of reinforcement bent, woven, folded, tied, sewn, twisted or otherwise formed to conform to reinforcement in the array to provide means for the girding or cincture of at least two elements of the reinforcement array.

Independent Aperture--Operation

[00111] Independently locatable apertures can be shaped in a variety of ways. When placed onto the array locatable apertures require cross reinforcement to be communicated into and held disposed within said aperture to effect installation of said aperture.

Double Webbed Trusses--Description

[00112] Trusses with apertures that contain at least one cord and at lease two web elements generally juxtaposed to one another to form, when viewed in the lateral cross section, opposing vertices across the transverse axis.

Double Webbed Trusses--Operation

[00113] All aperture trusses operate in a similar fashion and methodology, each having distinct differences in an engineered analysis.

Foundation or Grade Beam Reinforcement--Description

[00114] Trusses equipped with aperture devices are positioned to space, align, and support reinforcement extending through and between foundation cementations and connecting structures. Reinforcement passed through parallel or perpendicularly aligned vertices of such attached structures provides ductile, composite connections. In arrays in which vertices accept lateral reinforcement in perpendicular planes, said lateral reinforcement may be interlapped to cincture the structures together. Similarly such use is appropriate and desirable for bond beam construction.

Foundation or Grade or Bond Beam Reinforcement--Operation

[00115] Trusses of a beam system are oriented to trusses of a wall or foundation system such that vertices of the trusses align, thus allowing one or more elements of lateral reinforcement to pass through the vertices of both systems. In some orientations the cords of the trusses of the systems may be juxtaposed so that their vertices accept interlapped transverse reinforcement cincturing the systems together with a ductile connection when embedded in cementations.

One Cord Truss--Description

[00116] An asymmetrical truss with vertices bent in such a manner that said vertices grab or gird reinforcement such as the cord of another truss when cross reinforcement is disposed within said truss's apertures to provide means for additional lateral or longitudinal reinforcement and load resisting capacity.

One Cord Truss--Operation

[00117] This device is used at openings in arrays by attaching the un-corded and bent vertices to longitudinal or lateral cords in an array and cincturing said one cord truss to said array with cross reinforcement.

Conclusions, Ramifications, and Scope

[00118] Accordingly, it can be seen that the Anvick composite aperture connection of this invention can be used in structural cementations and other hybrid material structures.

[00119] The walls can be pre assembled, or pre-formed, offsite according to the required dimensions and then transported to the job site.

[00120] Rapid installation.

[00121] Can be made from 100% recycled materials.

[00122] Reduces demand on energy.

[00123] Structurally more efficient.

[00124] Materials and labor force readily available worldwide.

[00125] Meets extreme climactic, environmental and seismic challenges.

[00126] More durable structures.

[00127] Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Various other embodiments and ramifications are possible within it's scope. For example; a continuous element can be formed into an entire panel array forming transverse, lateral, and longitudinal elements from one continuous element. Simple trusses of conventional reinforcement bar can be permitted by building officials without need for testing.

Elements of differing configurations can be intermixed throughout an array. And many other potential configurations can be made.

[00128] Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.